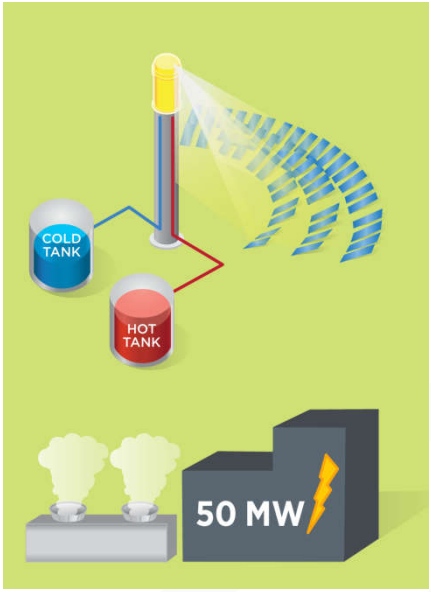
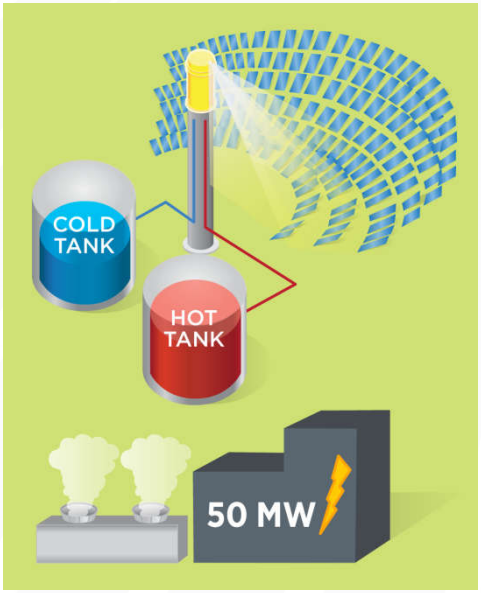
CSP: Flexible Solar Energy On-Demand for an Evolving Grid

'Peaker'
(≤6 hours of storage)



'Baseload'
(≥12 hours of storage)

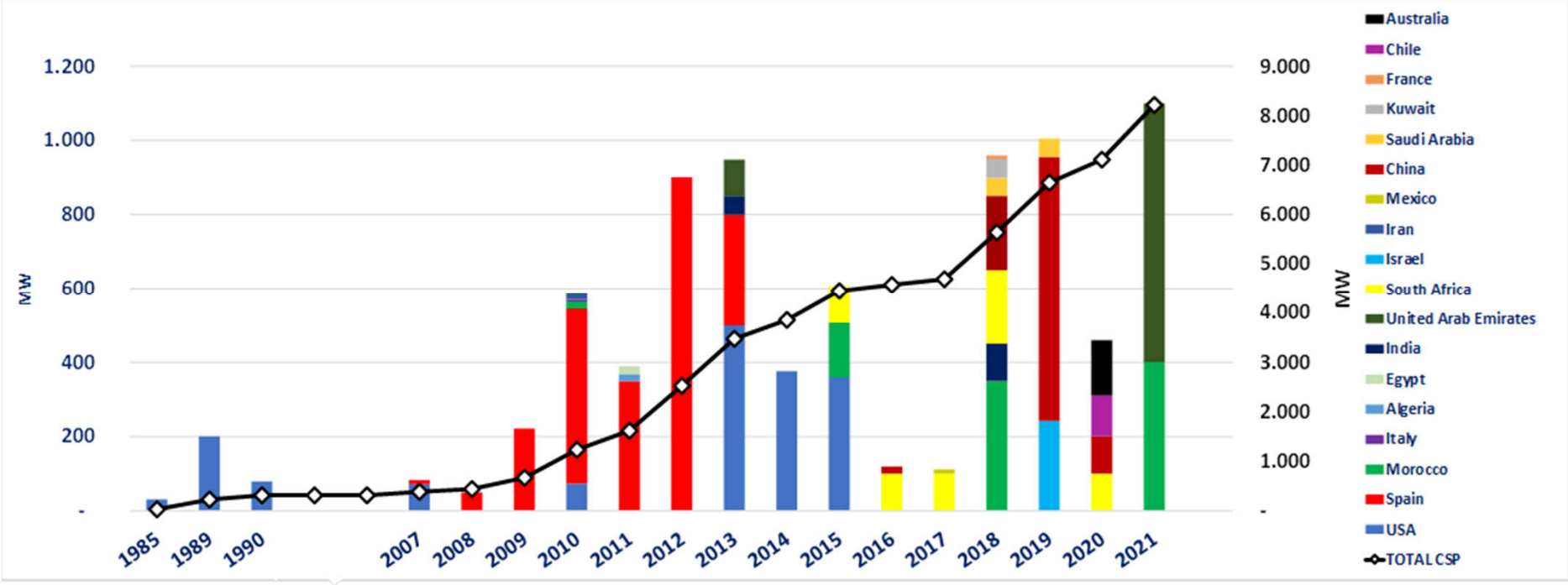


By choosing the size of the solar field and thermal energy storage, the same CSP technology can be configured to meet evolving demands of the grid

CSP in the international market

Market size = 800 -1000 MW / year

After stop of CSP markets in Spain and the US in 2016 new markets arise in South Africa, Morocco, China and UAE



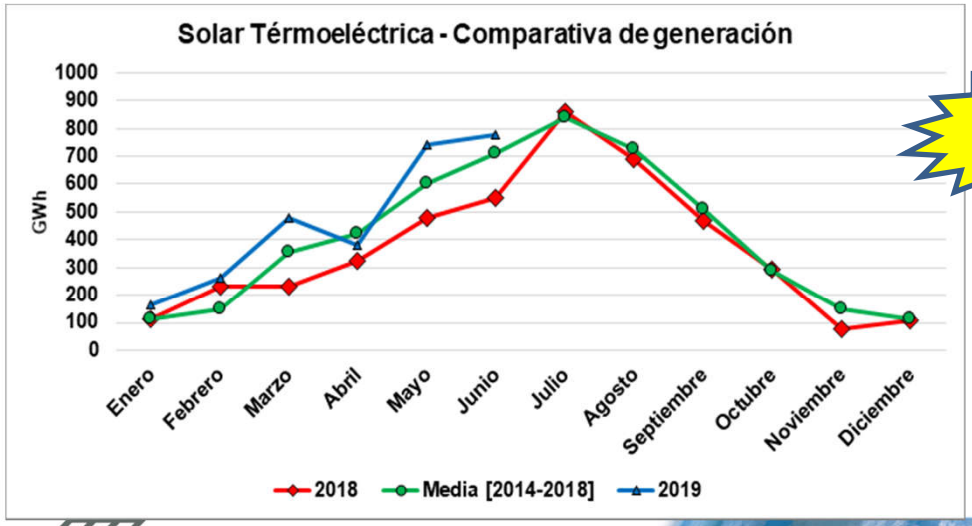
Operational Experience in Europe

The Spanish CSP operational fleet consist of 49 Plants with 2.300 MW. These plants entered in operation between 2007 - 2013.

The plants doesn't show degradation signs and they are continuously breaking specific records. 2019 is getting the maximum cumulative yield

Lessons learned on specific operational issues are part of the knowhow of the Spanish companies for design and operation of future plants

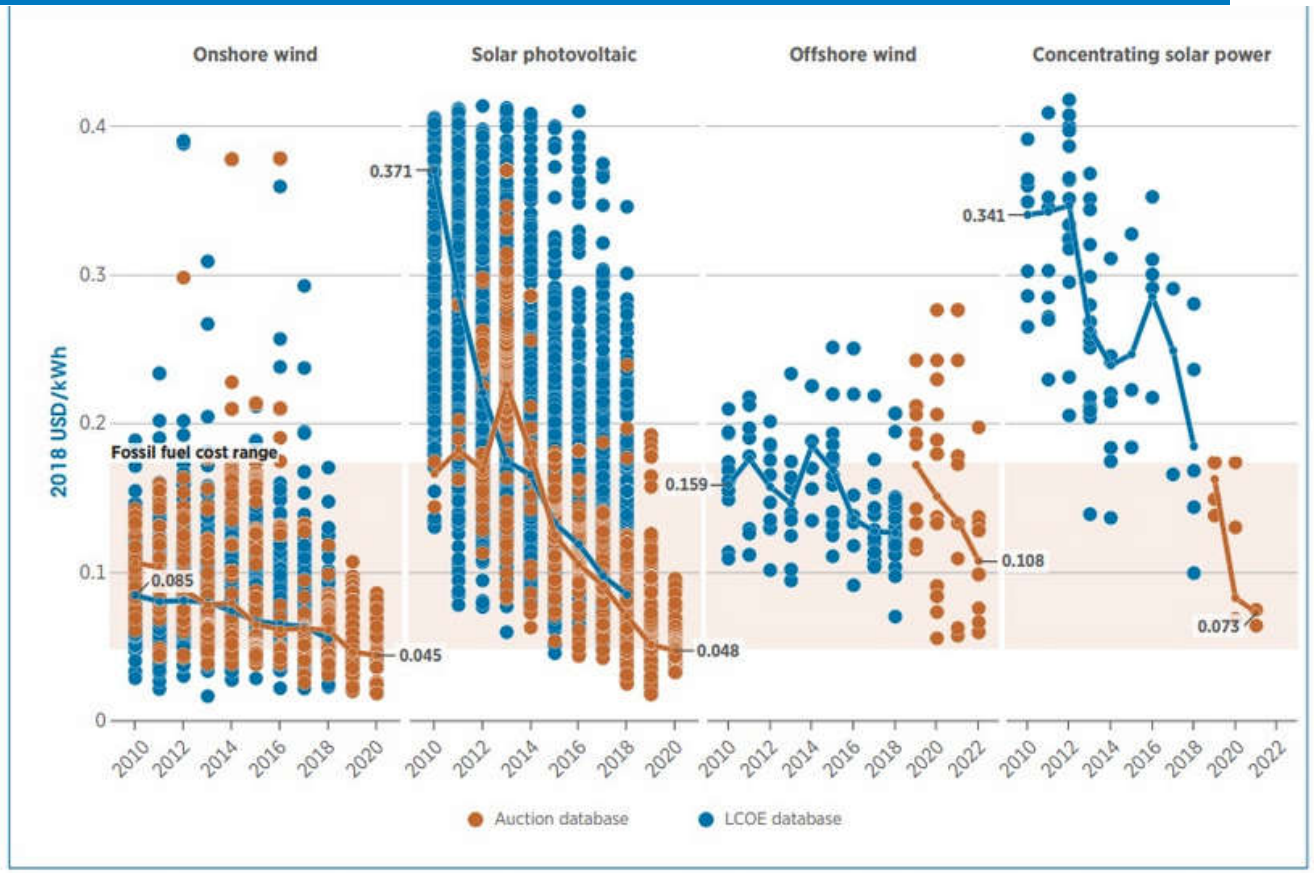
Type	Plants	Power (MW)
Parabolic Trough 50 MW without Storage	27	1350
Parabolic Trough 50 MW With storage	17	850
Saturated Steam Tower	2	31
Molten Salt tower with storage	1	20
Fresnel	1	30
Hybrid Solar/Biomass	1	22
TOTAL	**49**	**2303**



Historic records

- ✓ 10% of instantaneous contribution has been achieved. 8% is oftenly achieved in summer months.
- ✓ 3 weeks have been running some plants in a non stop 24/7 mode. Gemasolar, in particular, reached 36 non stop days at nominal power
- ✓ The cumulative record till June have been achieved in 2019

Cost Renewable Electricity



Hybrid renewable systems provide low cost *and* flexible operation

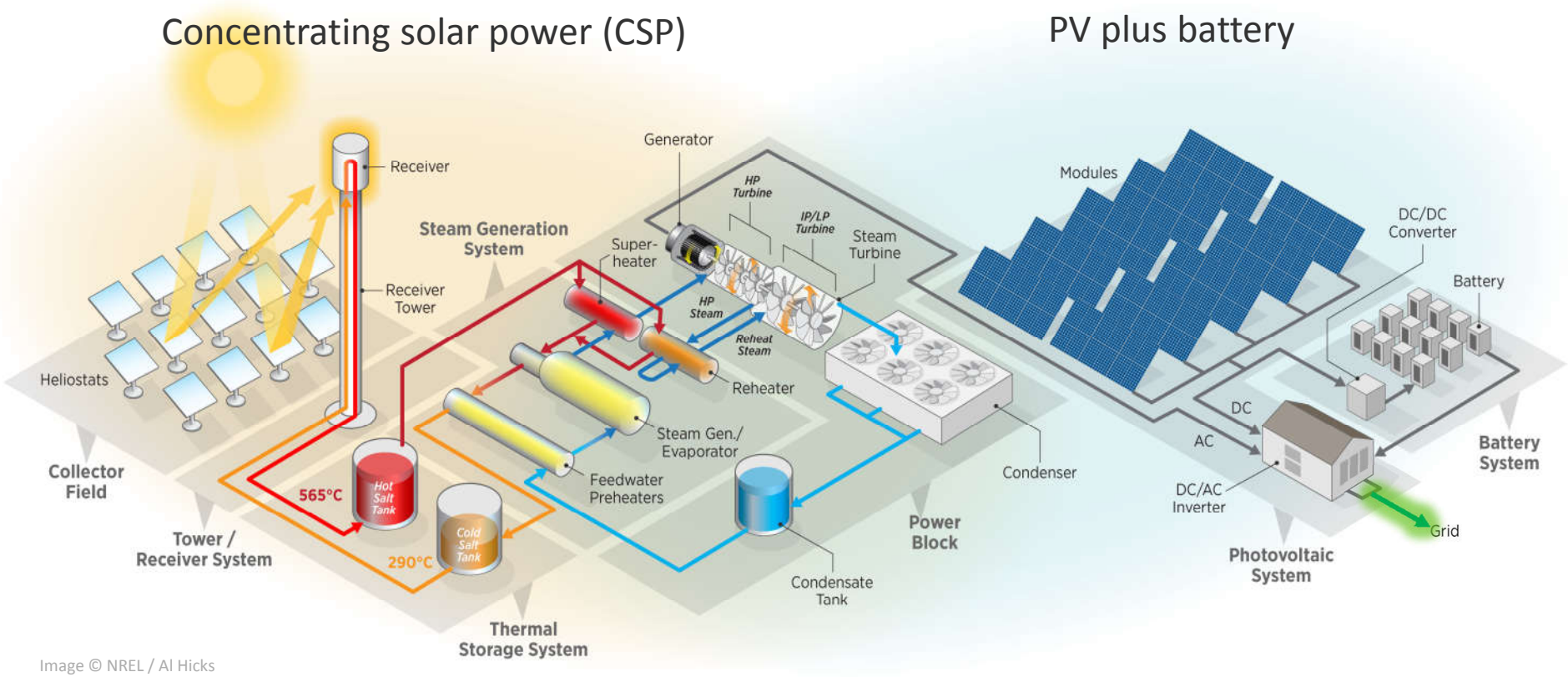
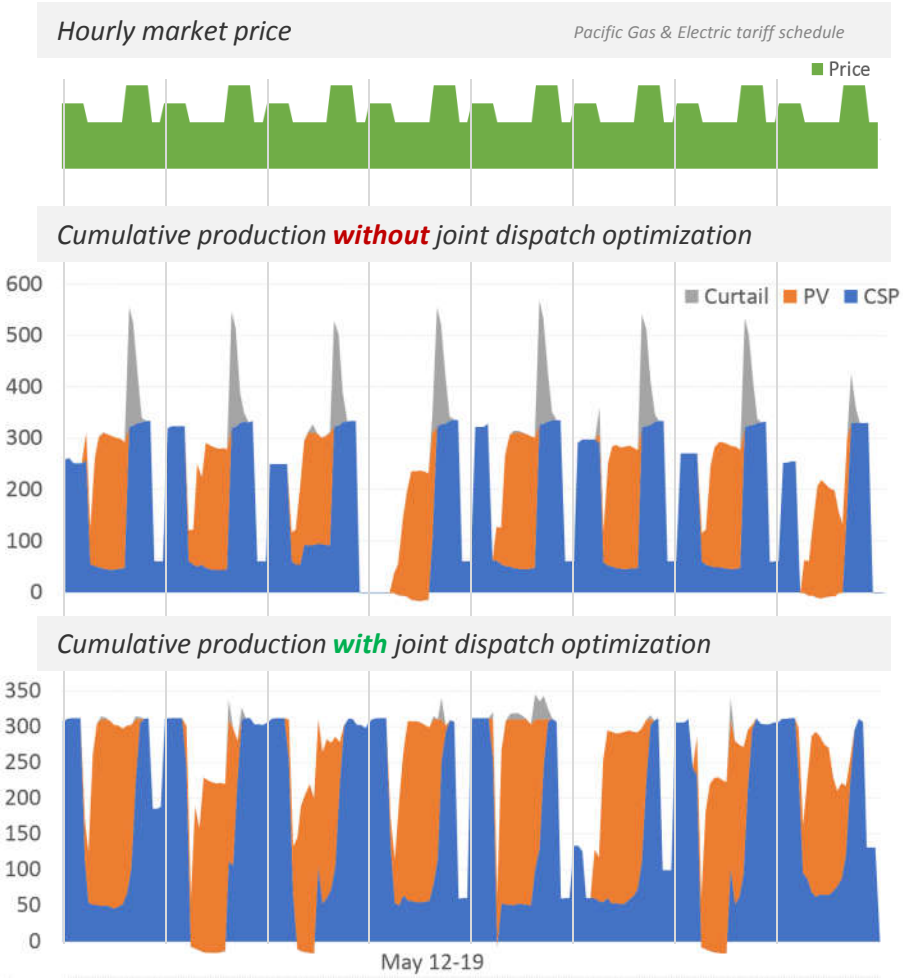


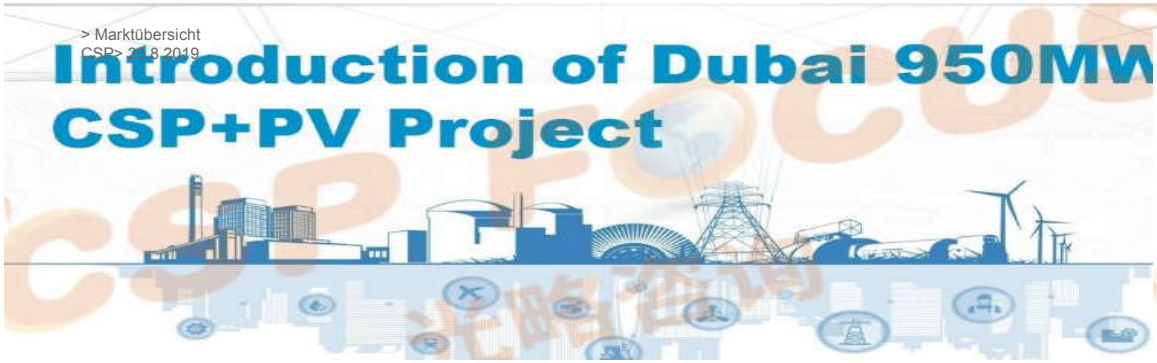
Image © NREL / Al Hicks

CSP and PV can produce complementary power

- Two forms of solar energy generation with differing characteristics can be used to meet market demands
- Optimized production from CSP can overlap PV
- *Cumulative* production of a paired plant exacerbates grid challenges or induces PV curtailment
- Goal: Shift CSP production using thermal storage to generate “around” PV



Introduction of Dubai 950MW CSP+PV Project



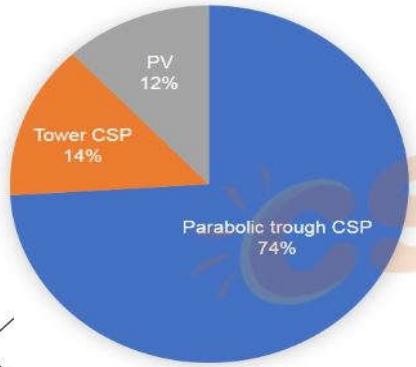
950 MW

700MW CSP

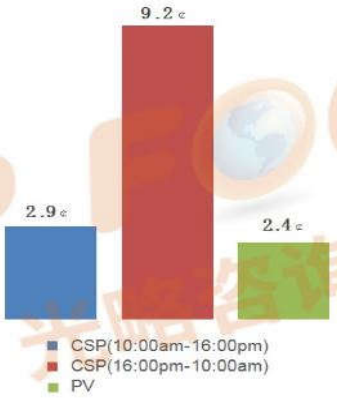
250MW PV

SHANGHAI ELECTRIC

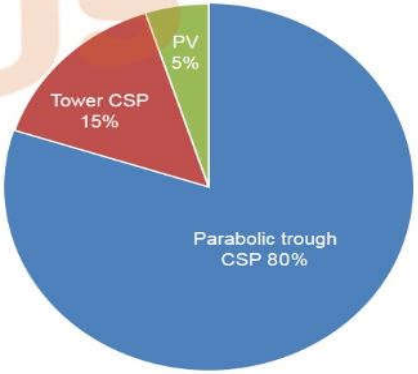
Most competitive price—USD 7.3 cents/kWh



Power Structure

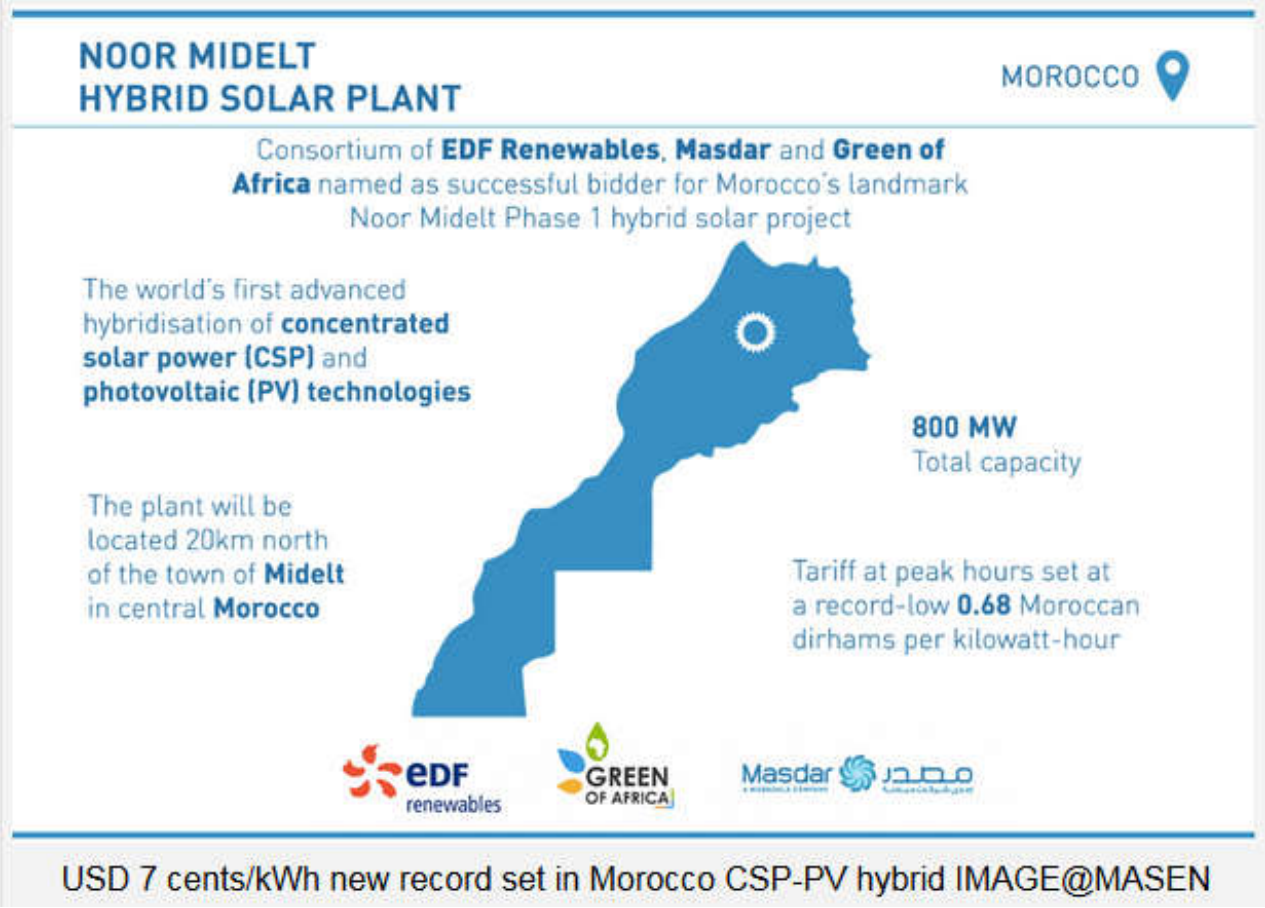


Price Difference



Revenue Structure

190 MW PV CSP Hybrid Awarded in Morroco



Photovoltaic Plant

100 MW

392,000 PV panels

Single-axis tracker

300 hectares

In Operation

CSP Plant

110 MW

10,600 heliostats,140 m^2 each

Tower of 243 meters

17.5 hours of storage

In Construction

A Landmark Project

First CSP plant in Latin America

PPAs competitively awarded in 2014

Overcame many external challenges

Under construction

Expected COD – May 2020

IEA SolarPACES

- **IEA SolarPACES VISION**

  Our vision is that concentrating solar technologies contribute significantly to the delivery of clean, sustainable energy worldwide.

- **IEA SolarPACES MISSION**

  Our mission is to facilitate technology development, market deployment and energy partnerships for sustainable, reliable, efficient and cost-competitive concentrating solar technologies by providing leadership as the international network of independent experts.

Solar Power and Chemical Energy Systems

SolarPACES membership 2019

- **Currently SolarPACES has 19 members:** Austria, Australia, Brazil, Chile, China, European Commission (DG RESEARCH and DG TREN), France, Germany, Greece, Israel, Italy, Mexico, Morocco, Republic of Korea, South Africa, Spain, Switzerland, United Arab Emirates and United States of America.
- **Potential new members are:** Namibia, Portugal,